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EVALUATION OF AN AUTOMATED METHOD FOR BLOOD GROUPING IN THE MILITARY SERVICE--A SYSTEM ANALYSIS

(Progress Report)

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ABSTRACT

EVALUATION OF AN AUTOMATED METHOD FOR BLOOD GROUPING IN THE MILITARY SERVICE--A SYSTEM ANALYSIS

OBJECTIVE

This study was designed to evaluate an automated system of blood grouping and apply it to the identification of blood types of newly inducted recruits in accordance with provisions of AR 40-3. Its purpose was to extend information on the accuracy of the system, and its reliability. It was also designed to assess the cost--both in supplies and personnel.

METHOD

An 8-channel AutoAnalyzer was employed with both standard and experimental antisera. The results were analyzed in accordance with the objectives.

CONCLUSIONS

The results indicate that the system is highly reliable, being virtually error-free, provided an appropriate sample is obtained for analysis. It is believed that the employment of this system will provide the US Army with a highly reliable, practical method for implementing the requirements of AR 40-3. The system appears clearly to be more cost-effective than one utilizing manual methods alone.

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EVALUATION OF AN AUTOMATED METHOD FOR BLOOD GROUPING IN THE MILITARY SERVICE--A SYSTEM ANALYSIS

INTRODUCTION

The purpose of this study was to apply recently developed automated blood grouping methods to the identification of blood types of newly inducted recruits in accordance with provisions of AR 40-3. The following factors were evaluated:

a. Accuracy of the system.

b. Reliability.

c. Cost of the system.

d. Requirements for personnel and training.

BACKGROUND

Human blood groups provide an important method of individual identification. The US Army began blood typing of individuals for this purpose in 1941 by placing the ABO group on identification tags*. The objective was "to make possible the calling of voluntary donors of a specific blood type and securing them on very short notice." Without such grouping it would be necessary to call at least 200 prospective donors to find approximately 100 of group O. *The information was not to be used to eliminate the need for crossmatching prior to transfusion.* Errors in grouping were immediately encountered and a letter of instruction to control variations in technic had to be issued (1).

The error rate through the years has been evaluated repeatedly and found to vary with the methods and reagents used and the skill of the technicians performing the test. In general, an error rate of 5 to 12% has been found. Based on the retyping of 573 individuals from both CONUS and Europe, a recent study performed in this laboratory found a difference of 8.6% in the blood group recorded on the individual identification records and the actual blood group.

If the original objective of mass blood grouping is not misunderstood, and no additional use is made of the information, one can perhaps argue that such an error rate is acceptable. Unfortunately, this objective is misunderstood. For example, information that the Army has possibly more than 100,000 men erroneously typed at the present time is most

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[1] Kendrick, D. B. Blood Program in World War II. Chapter X, Blood Typing of Military Personnel, p. 233 ff., 1964.

* "Dog tags."

alarming and publicity to this effect periodically causes unfavorable, if not unjustified, criticism. Furthermore, since great accuracy is now technically possible, additional objectives for mass blood grouping are desirable. For instance, if a system provided completely accurate blood group information, it conceivably could be used in transfusion therapy, *to unravel blood groups after universal donor blood, to identify the remains of casualties,* and for *additional medicolegal purposes, such as paternity exclusion.* Finally, there is an inherent desirability for achieving complete accuracy in any undertaking and only considerations of cost can be used as an argument for not working toward such a goal.

The desirability for an improved system of identification resulted in the publication of Change 14 to AR 40-3 on 3 February 1967, which required the determination of Rh type and that red cell tests be confirmed by serum tests. Unfortunately, little consideration was given to the implementation of such a requirement. The cost, both in supplies and personnel, to accomplish these requirements has made compliance irregular and also has not improved the error rate.

The present study was designed to evaluate an automated system which, in pilot studies, proved to be highly accurate (2). Its purpose was to extend information on the accuracy of the system, its reliability, and to assess its cost, both in supplies and personnel. Only through such an evaluation can the wisest decision be reached regarding the employment of such a system for the Army.

MATERIALS AND METHODS

Instrument. The automated blood grouping studies were conducted on an 8-channel analyzer (AutoAnalyzer - Technicon, Inc. (Fig. 1, page 9)). This instrument will be available commercially with 10 channels and the cost data were made on this basis. Three channels were used for serum typing, using known A, B, and O cells. Four channels were used for cell typing, using anti-A, anti-B, anti-D, and anti-CDE antisera. The remaining channel was used as a saline control against the unknown cells. On the new commercially available 10-channel instrument, two additional channels will be available for simultaneous tests to meet the individual user's needs, i.e., serology, heterophil, etc.

Reagents. Two types of reagents were used in the study--standard items available through normal military supply channels and lyophilized antisera, especially designed for automated use, supplied on an experimental basis by the Dade Division of American Hospital Supply Corporation.

[2]Shields, C. E., F. R. Camp, Jr., and Judy W. Adams. Evaluation of automated multi-channel blood grouping apparatus I. Procedure and reagent standardization for blood grouping. USAMRL Report No. 806, 24 Dec 1968 (DDC AD No. 686270).

Standard reagents were diluted as follows for AutoAnalyzer use:

Anti-A and B	Anti-B	Control Blank
5 ml antiserum	8 ml antiserum	50 ml albumin
8 ml PVP	18 ml PVP	9 ml PVP
100 ml albumin	100 ml albumin	qs 100 ml with 1.3% saline
qs 200 ml with 1.3% saline	qs 200 ml with 1.3% saline	

Reagents:

1. Albumin 2% (Bovine Armour's Fraction 5) in 1.3% saline.

2. PVP 5% K90 in 1.3% saline.

3. Bromelin 0.15% in 1.3% saline containing four drops Tween 20. Three grams bromelin in 500 ml 1.3% saline were dissolved and filtered and diluted to 2000 ml with 1.3% saline.

The lyophilized antisera which were tested during the period 17 January to 29 March 1969 were supplied in 50 ml vials and simply required dilution to 50 ml with distilled water.

Reagent cells were prepared as a 5% solution as follows: 5 ml packed cells; 50 ml bromelin; 25 ml albumin; 4 ml PVP - qs to 100 ml with 1.3% saline.

A diagram of the reaction is shown in Figure 2 (page 10); interpretation of the reactions is shown in Figure 3 (page 11).

PROCEDURE

Venipuncture specimens were obtained by US Ireland Army Hospital laboratory personnel assigned to Medical Processing at the USATCA Reception Center. Each receptee was given his blood specimen tube to which he affixed a label containing his name and a number. The specimen was placed in the tube by the laboratory technician who in turn transcribed the number to a roster. Results were recorded on the roster, checked against both a name and number. The system had little room for clerical error. Samples were collected in test tubes containing EDTA (FSN-6630782606) and were rotated for 1 minute on a multipurpose rotator. This proved to be an important step to avoid clogging of the system. When an incomplete specimen was obtained, the test was performed by trained laboratory personnel by manual methods (3). When no specimen

[3] TM 8-227-3, Laboratory Procedures in Blood Banking and Immunohematology, Department of the Army, Nov 1966.

could be obtained, a finger stick sample of blood was grouped by slide test (manually) by US Ireland Army Hospital personnel and these results were used to record the blood group (3). Obviously, a satisfactory specimen is a requirement for the automated system and inability to obtain one represents a system failure.

The specimens from each day's input of receptees were largely obtained after 1800 hours each day and delivered to the laboratory for study the following morning. The specimens were centrifuged at 3,000 rpm/10 min in an International centrifuge (Model No. CS). Each day's input was run in the forenoon, interpreted, recorded, and made available to the Reception Center as input to a dog tag printer by noon of the same day.

To cross-check the accuracy of the system, follow-up samples were obtained for blood grouping, either when the individual returned to donate a unit of blood, or from a random sample obtained during subsequent basic training. Three hundred and sixty-one specimens were obtained from blood donors and 314 from randomly selected individuals during basic training.

After analysis of the specimens on the automated system, the results were compared to the blood type recorded on the identification tag or record. Discrepancies were rechecked by manual methods. Clerical error was considered to have occurred when subsequent testing confirmed the initial test result, but the record was erroneous.

In order to compare the error rate under these controlled conditions with that currently present in the Army, random samples were drawn from individuals stationed in different Army areas as follows: 153 specimens were obtained from the US Army, Europe; 147 from units within First Army; 135 from units within Third Army; and 138 from units within Fourth Army.

These were tested by the AutoAnalyzer and the results were compared to the information on the dog tag.

Cost Studies. The objective of this part of the study was to develop per sample costs for both the automated and manual techniques which are necessary to fulfill the requirements of AR 40-3. The blood grouping procedures included ABO typing of both serum and cells and Rh typing of the cells.

The following types of cost data were collected:

1. Direct labor. Only labor time directly involved in processing blood samples or reagent preparation was considered. Supervisory labor or overhead labor was excluded. Labor costs were constructed from time study analyses of each procedural step and, as such, represent total minutes of labor time required per sample.

2. Direct materials. All materials used in processing have been included. Items normally considered as overhead, such as clerical supplies, were excluded.

3. Equipment. The only piece of equipment included was the AutoAnalyzer, since all other items (i.e., serofuges, etc.) used in both manual and automated procedures are considered to be available in standard medical laboratories and are equally required regardless of method used.

Cost data were developed for the manual method and for the AutoAnalyzer under two conditions--using lyophilized or standard antisera. Lyophilized antisera were especially prepared* for use in the automated system on an experimental-use-only basis. For costing, the price estimate from the manufacturer was used, which may be lower if the material is licensed for routine commercial marketing.

It was assumed for purposes of this study that the AutoAnalyzer will last ten years. Its initial cost will be $18,000 and will cost $900/year to maintain. Labor costs were assumed to approximate $5/hour.

RESULTS

During the period 1 January to 2 May 1969, 17,633 specimens were processed. During the period 1 March to 2 April 1969, a total of 3,423 receptees was processed by the USATCA Reception Station. In 19 instances (0.6%), personnel were unable to obtain a venous blood sample and were required to perform blood grouping by slide method from blood obtained by finger puncture. In 735 instances (22%), an inadequate or clotted sample unsuitable for AutoAnalyzer evaluation was obtained--on which manual tests were performed by trained personnel in USAMRL.

The remaining 2,669 (77.4%) samples were evaluated by the automated system. During the period 24 March to 24 April 1969, a total of 675 samples was collected in order to recheck the initial blood grouping and to determine the error rate. The results revealed a total of eight discrepancies. In no instance was the AutoAnalyzer responsible.

An analysis of these discrepancies showed them to be eight Rh errors and three ABO. The three samples with errors in ABO typing also had incorrect Rh results. The three ABO errors occurred in the slide typing in the Reception Station, performed when a venous specimen was not obtainable. In three instances, a clear-cut clerical error was responsible, since the typing was correct but the entry on the dog tag did not correspond to the typing result. In the remainder, errors were made by skillful personnel using manual methods on specimens that were inadequate to run by the automated technique. All the Rh errors were

*Dade Division of American Hospital Supply Corporation.

minor compared to the ABO errors, and consisted of recording Rh negative when, in fact, the individual was positive. The ABO errors were serious. Two instances were found of O recorded as B, and in one instance, a group O individual was recorded as a group A. The system error rate was 8/675 (1.6%) and all of these fell into the groups with a sample collection problem.

Results of testing 573 samples obtained throughout CONUS and USAREUR revealed 49 discrepancies, for an overall error rate of 8.6%. The results are displayed in Table 1.

TABLE 1

Army Area	Sample No.	Discrepancies	
		No.	%
USAREUR	153	15	9.8
First Army	147	13	8.9
Third Army	135	15	11.1
Fourth Army	138	6	4.4
TOTALS	573	49	8.6

Cost Data.

Manual System:

Manual processing costs were found to be:

Direct Labor	$ 0.204
Direct Materials	0.201
Fixed Cost	11.67

Costing details are shown in Schedule 1 (page 12). Total cost per sample ranges from $0.522 at 100 sample/day to $0.428 at 500 samples, as shown in Schedule 2 (page 13).

Automated System:

Labor. Variable labor costs are identical, using either lyophilized or standard antisera, as shown in Schedule 3 (page 14). The variable labor is limited to labeling tube samples for processing and transcribing results. Thus, variable labor requirements are less than 2 minutes/sample. However, a significant amount of time is required to prepare the machine for each day's processing. The lyophilized antisera are very simple to mix and can be prepared in about 5 minutes, while use of standard antisera requires approximately 1 hour of preparation.

Materials. The cost of materials varies widely with the type of antisera used. Those materials common to both types of processing are shown in part A of Schedule 4 (page 15) and amount to little more than

$.04/sample. The lyophilized antisera add almost $.25 more to the per sample cost, while standard antisera cost less than $02.5/sample. Thus, the variable cost for materials using lyophilized antisera equals $.32/sample, compared with $06.5/sample processed with standard antisera. Fixed materials costs are incurred for the daily preparation of known cell suspensions and are the same under either method of automated processing.

Equipment. The amortization and maintenance costs associated with the AutoAnalyzer are shown in Schedule 5 (page 16).

Schedule 6 (page 17) displays the relationship of sample size to cost for each type of antisera, and Schedule 7 (page 18) displays the relationship between sample size and cost broken down between labor and materials for each technique. While the total cost per sample is greatest using lyophilized reagents at any sample size, the labor cost is lowest using this technique at a sample size greater than 150. This relationship is shown graphically in Charts A and B (pages 19 and 20).

DISCUSSION

The Blood Transfusion Division has as one of its objectives the task of evaluating new blood banking methods. One of the recent innovations in this field is the introduction of automation in blood grouping. When this requirement for blood grouping involves large numbers of samples, an automated method should prove of great value. The military services have such a requirement for mass blood grouping. In addition, manual methods have proved unreliable and inaccurate. In a pilot study done in this laboratory, an automated method using the Technicon AutoAnalyzer was demonstrated to be very reliable (2). This study was done as an extension of that effort to obtain system analysis information as accurately as possible in order to determine whether the system could be employed as an effective means of implementing the requirements of Change 14 to AR 40-3, dated 3 February 1967.

The results indicate that the system is highly reliable--being virtually error-free--provided an appropriate sample is obtained for analysis. It was very disturbing to obtain less than 80% adequate specimens during this particular period of the study and it demonstrated a major problem area in the system. Since the study was carried out over several months, it was possible to reduce this inadequate specimen rate to less than 5% by better training and supervision of the sample collection. It should be possible to eliminate this problem but it will doubtless require continuous supervision and effort.

The cost information can be viewed in several ways. We were frankly surprised that the system using lyophilized reagents is actually more costly for 300 samples daily than either the manual or automated systems using standard reagents--$0.59 versus $0.44 and $0.35, respectively. Nevertheless, there are several points to be added. The lyophilized

reagent automated system is the least costly in labor--$0.173 versus $0.210 and $0.190, respectively, for a 300 sample size (Chart B). The data are somewhat misleading in that the labor costs do not take into account manning levels which would be required to accomplish the testing in the time constraint that does in fact exist. It is certain that more personnel would be required to perform the tests manually than would be true with the automated method and this is not reflected in the labor cost data. *Technicians can perform their tasks on the AutoAnalyzer handily, as computed in this study, whereas the tasks for manual testing have been computed as though they could be accomplished as a continuous operation and this is, of course, not possible.** A 20% labor cost increase is probably not unrealistic when evaluating the manual method.

Furthermore, the increased cost of the lyophilized reagent automated system is almost entirely due to reagent costs. This logically can be expected to come down, whereas labor costs cannot. Since in today's world, the resource of personnel is much more valuable than dollars, this aspect of the evaluation deserves emphasis. Furthermore, it would appear logical to expect that in a reasonable period, the total cost of this system would be reduced as well.

Our experience with this equipment over the past two years has shown it to be quite reliable. Such a piece of equipment will require two specially trained medical technicians. The training can be accomplished as an on-the-job training project and should not require any formalized or special course work.

It is believed that the employment of this system will provide the US Army with a highly reliable, practical method for implementing the requirements of AR 40-3. The system appears clearly to be more cost-effective than one utilizing manual methods alone.

The use of standard antisera is less costly than the use of a lyophilized product, based upon best current estimates of the cost of the material, but should prove progressively less so as the lyophilized material becomes more competitive.

[4] Includes factors of boredom, dangerous shortcut procedures and fatigue.

Fig. 1. AutoAnalyzer.

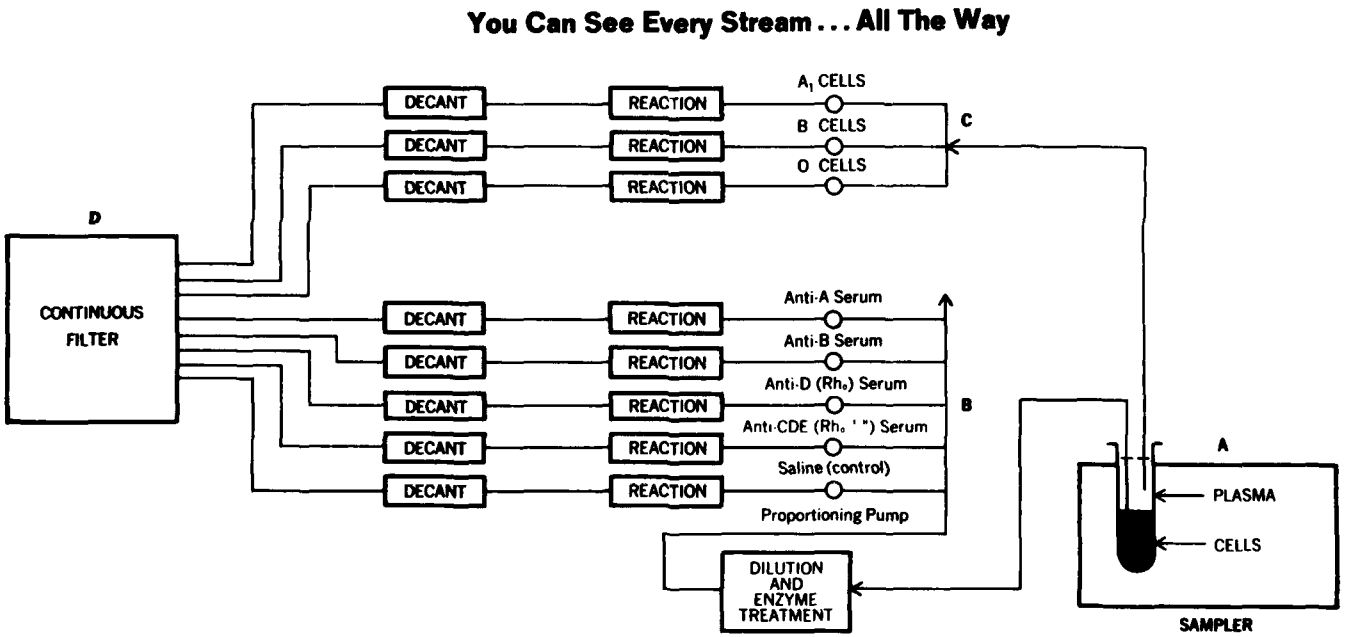

Fig. 2. Reaction diagram.

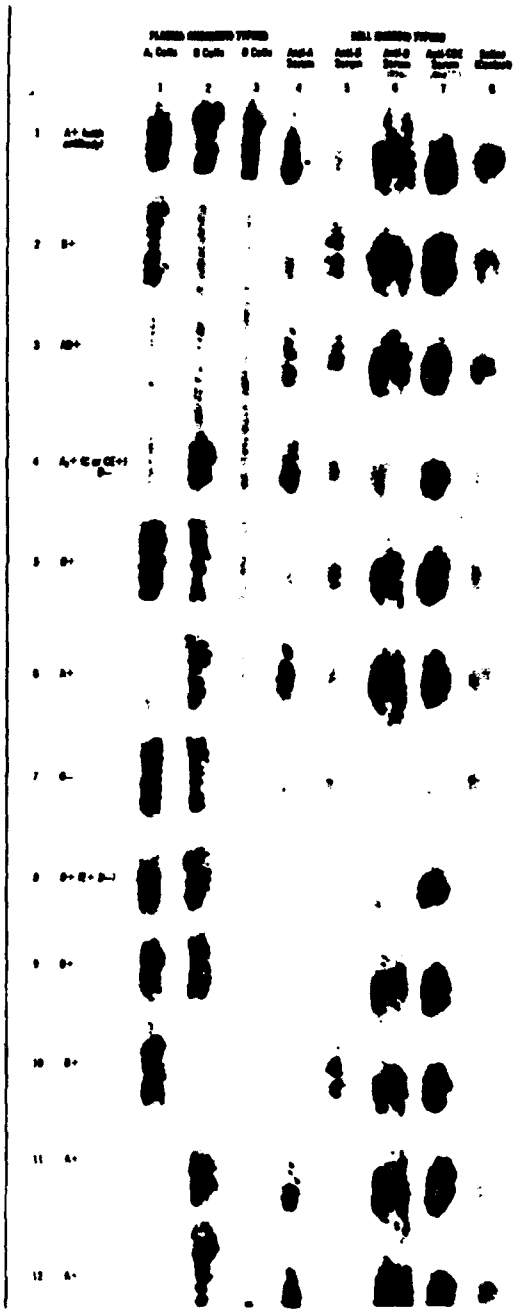

Fig. 3. Reaction interpretation.

SCHEDULE 1

MANUAL PROCESSING COSTS

Activity	Labor For 100 Samples		Materials Used Per 100 Samples		TOTAL COST
	Minutes	Cost	Description	Cost	
ABO AND Rh CELL TYPING					
1. Number vacutainers and roster	50.0	$ 4.167	100 vacutainers	$ 3.600	
			5 roster forms	0.106	$ 7.873
2. Shake, remove caps, centrifuge	35.0	2.917			2.917
3. Set up test tubes	6.7	0.558	300 disp. tubes	4.344	4.902
4. Add antisera	11.3	0.942	5 ml anti-A	1.210	
			5 ml anti-B	1.230	
			5 ml anti-D	3.800	7.182
5. Add cell samples	13.3	1.108	300 applicator sticks	0.330	1.438
6. Inspect and record results	19.7	1.642			1.642
7. Rh negative test on 15% of samples					
a. Set up tubes			30 disp. tubes	0.434	
b. Add albumin and anti-CDE	6.2	0.517	3/4 ml albumin	0.255	
			3/4 ml anti-CDE	0.315	
			30 applicator sticks	0.033	1.554
c. Incubate, serofuge, inspect	5.8	0.483			0.483
d. Wash three times, add Coombs, inspect and record	8.7	0.725	3/4 ml Coombs	0.334	1.059
SUBTOTAL:	156.7	$13.059		$15.991	$29.050
SERUM TYPING					
8. Set up tubes	6.7	$ 0.558	200 disp. tubes	$ 2.896	$ 3.454
9. Add serum	43.8	3.650	100 dispopipettes	1.236	4.886
10. Add known cells	11.3	0.942	Fixed cost*		0.942
11. Serofuge	6.2	0.517			0.517
12. Inspect and record	19.7	1.642			1.642
SUBTOTAL:	87.7	$ 7.309		$ 4.132	$11.441
TOTAL VARIABLE COST:		$20.368		$20.123	$40.491
VARIABLE COST PER SAMPLE:		$ 0.204		$ 0.201	$ 0.405

*Fixed cost: Preparation of cells of Type A and B for serum testing (1 to 500 samples)

Cells:	Type A =	$ 5.00
	Type B =	5.00
Labor:	20 min (@$5.00/hr)	1.67
		$11.67

SCHEDULE 2

MANUAL PROCESSING

Cost Related to Batch Size

Number of Samples	Variable Labor	Variable Materials	Fixed Cost	Total Cost	Cost Per Sample
100	$ 20.37	$ 20.12	$11.67	$ 52.16	$0.522
150	30.55	30.18	11.67	72.40	0.483
200	40.74	40.25	11.67	92.66	0.463
250	50.92	50.31	11.67	112.90	0.452
300	61.10	60.37	11.67	133.14	0.444
350	71.29	70.43	11.67	153.39	0.438
400	81.47	80.49	11.67	173.63	0.434
450	91.66	90.55	11.67	193.88	0.430
500	101.84	100.62	11.67	214.13	0.428

SCHEDULE 3

AUTOANALYZER PROCESSING (LABOR)

A. Variable Labor Costs Activity	Labor Per 100 Samples Minutes	 Cost
1. Number vacutainers and roster	50	$ 4.167
2. Shake and remove caps	10	0.833
3. Remove clots	8	0.667
4. Centrifuge	25	2.083
5. Process: effective rate of 100 samples per hour Machine operator	60	5.000
6. Transcribe results	25	2.083
TOTAL VARIABLE LABOR:	178	$14.833
VARIABLE COST PER SAMPLE:		$ 0.148

B. Fixed Labor Costs (Per Batch) Activity	Minutes Per Batch Lyophilized Reagents	 Standard Reagents
1. Prepare known cells	20	20
2. Clean analyzer	65	65
3. Prepare reagents	$\frac{5}{90}$	$\frac{60}{145}$
COST PER BATCH @$5.00/HR:	$7.500	$12.083

SCHEDULE 4

AUTOANALYZER PROCESSING (MATERIALS)

A. Variable Materials (excluding antisera) Description	Materials Used Per 100 Samples Quantity	Cost
1. Vacutainer	100	$ 3.600
2. Saline solution (1.3%)	52 g	0.119
3. Urea NaOH wash solution		0.018
4. Filter paper		0.577
5. Result forms	5	0.106
SUBTOTAL:		$ 4.420

B. Antisera	Quantity	Cost Per 100 Samples Lyophilized Antisera	Standard Antisera
1. Anti-A	25.8 ml	$ 4.128	$ 0.312
2. Anti-B	26.6 ml	4.256	0.325
3. Anti-D	21.8 ml	5.232	0.796
4. Anti-CDE	21.8 ml	5.232	0.499
5. Control	18.5 ml	4.440	0.113
6. Bromelase	22.6 ml	4.520	0.100
SUBTOTAL:		$27.808	$ 2.145
PLUS OTHER VARIABLE MATERIALS (A ABOVE):		$ 4.420	$ 4.420
TOTAL VARIABLE MATERIALS:		$32.228	$ 6.565

C. Fixed Materials Costs Per Batch	Quantity	Cost
1. Known cells	3 samples	$15.000
2. Bromelin	1.5 g	0.221
3. Albumin	4 g	2.400
4. PVP	5 g	0.113
TOTAL FIXED COSTS:		$17.734

SCHEDULE 5

AUTOANALYZER PROCESSING (EQUIPMENT COST)

Initial Cost to Federal Government of 10-Channel Technicon AutoAnalyzer	$18,000
Estimated Life	10 years
Annual Amortization	$ 1,800
Plus: Annual Maintenance Contract	$ 700
Miscellaneous Parts Allowance	200
Annual Cost	$ 2,700
Assuming 250 Operating Days Per Year, Daily Cost Equals	$ 10.80

SCHEDULE 6

AUTOANALYZER PROCESSING

Cost Related to Batch Size

Number Samples	Using Lyophilized Antisera					Using Standard Antisera				
	Variable Labor	Variable Materials	Fixed Cost*	Total Cost	Cost Per Sample	Variable Labor	Variable Materials	Fixed Cost**	Total Cost	Cost Per Sample
100	$ 14.83	$ 32.23	$ 36.03	83.09	$ .831	$ 14.83	$ 6.57	$ 40.61	$ 62.01	$ .620
150	22.25	48.34	36.03	106.62	.711	22.25	9.85	40.61	72.71	.485
200	29.67	64.46	36.03	130.16	.651	29.67	13.13	40.61	83.41	.417
250	37.08	80.57	36.03	153.68	.615	37.08	16.41	40.61	94.10	.376
300	44.50	96.68	36.03	177.21	.591	44.50	19.70	40.61	104.81	.349
350	51.92	112.80	36.03	200.75	.574	51.92	22.98	40.61	115.51	.330
400	59.33	128.91	36.03	224.27	.561	59.33	26.26	40.61	126.20	.316
450	66.75	145.03	36.03	247.81	.551	66.75	29.54	40.61	136.90	.304
500	74.17	161.14	36.03	271.34	.543	74.17	32.83	40.61	147.61	.295

*Includes $7.50 fixed labor, $17.73 fixed materials, and $10.80 for amortization and maintenance of AutoAnalyzer.

**Includes $12.08 fixed labor, $17.73 fixed materials, and $10.80 for amortization and maintenance of AutoAnalyzer.

SCHEDULE 7

COST COMPARISON--MANUAL VS AUTOMATED TECHNIQUES

Number of Samples	Labor Cost			Materials Cost			Equipment Amortization Cost	Total Cost		
		AutoAnalyzer			AutoAnalyzer				AutoAnalyzer	
	Manual	Lyophilized	Standard	Manual	Lyophilized	Standard		Manual	Lyophilized	Standard
					A. BATCH COST					
100	$ 22.04	$ 22.33	$ 26.91	$ 30.12	$ 49.96	$ 24.30	$ 10.80	$ 52.16	$ 83.09	$ 62.01
150	32.22	29.75	34.33	40.18	66.07	27.58	10.80	72.40	106.62	72.71
200	42.41	37.17	41.75	50.25	82.19	30.86	10.80	92.66	130.16	83.41
250	52.59	44.58	49.16	60.31	98.30	34.14	10.80	112.90	153.68	94.10
300	62.77	52.00	56.58	70.37	114.41	37.43	10.80	133.14	177.21	104.81
350	72.96	59.42	64.00	80.43	130.53	40.71	10.80	153.39	200.75	115.51
400	83.14	66.83	71.41	90.49	146.64	43.99	10.80	173.63	224.27	126.20
450	93.33	74.25	78.83	100.55	162.76	47.27	10.80	193.88	247.81	136.90
500	103.51	81.67	86.25	110.62	178.87	50.56	10.80	214.13	271.34	147.61
					B. COST PER SAMPLE					
100	$.220	$.223	$.269	$.301	$.500	$.243	$.108	$.522	$.831	$.620
150	.215	.198	.229	.268	.440	.184	.072	.483	.711	.485
200	.212	.186	.209	.251	.411	.154	.054	.463	.651	.417
250	.210	.178	.197	.241	.393	.137	.043	.452	.615	.376
300	.209	.173	.189	.235	.381	.125	.036	.444	.591	.349
350	.208	.170	.183	.230	.373	.116	.031	.438	.574	.330
400	.208	.167	.179	.226	.367	.110	.027	.434	.561	.316
450	.207	.165	.175	.223	.362	.105	.024	.430	.551	.304
500	.207	.163	.173	.221	.358	.101	.022	.428	.543	.295

COST PER SAMPLE – MANUAL vs TWO AUTOMATED PROCEDURES

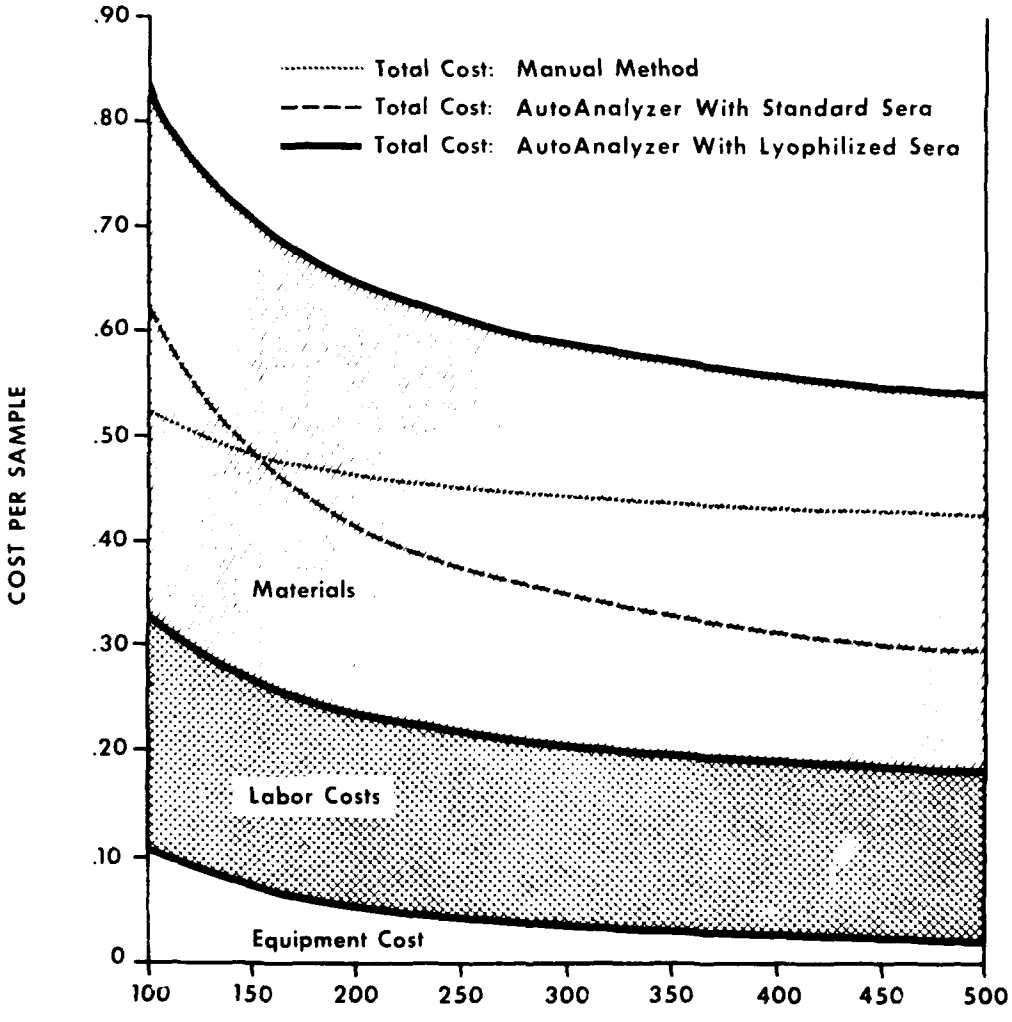

Chart A

COST PER SAMPLE - MANUAL vs TWO AUTOMATED PROCEDURES

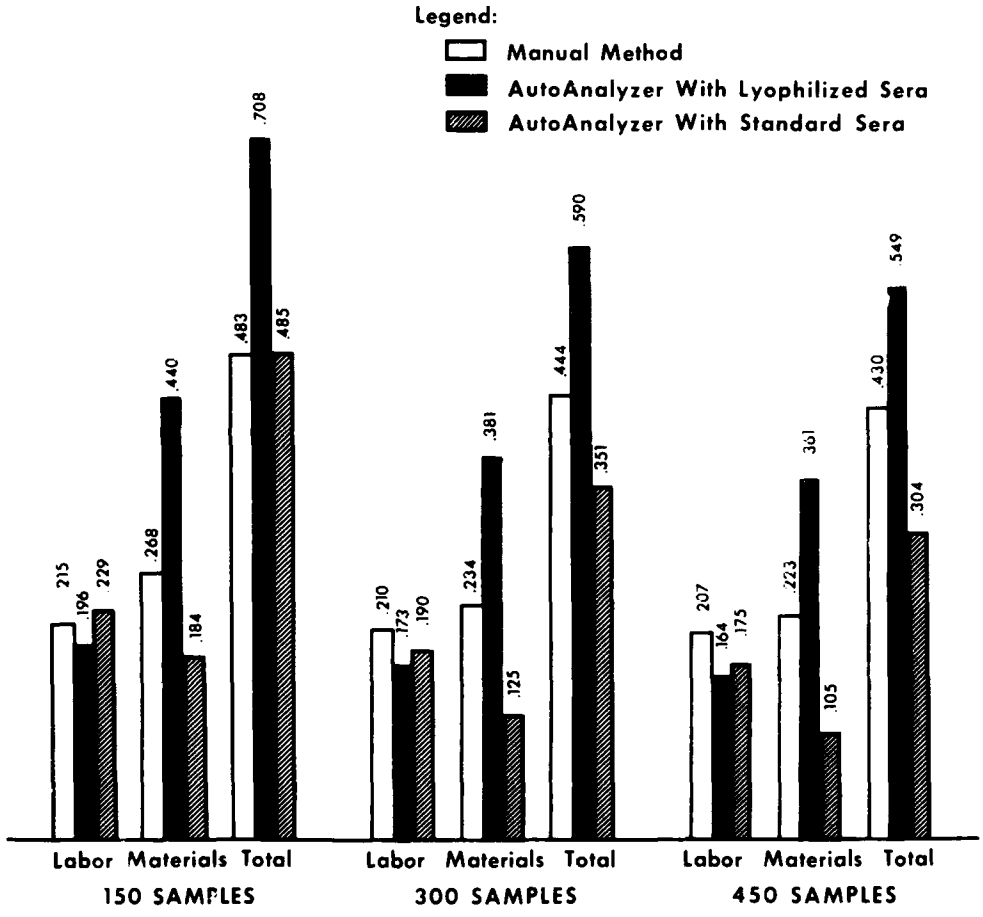

Chart B

UNCLASSIFIED

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EVALUATION OF AN AUTOMATED METHOD FOR BLOOD GROUPING IN THE MILITARY SERVICE--A SYSTEM ANALYSIS

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Progress Report

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13. ABSTRACT

The study was designed to evaluate an automated system of blood grouping and apply it to the identification of blood types of newly inducted recruits in accordance with provisions of AR 40-3. Its purpose was to extend information on the accuracy of the system, and its reliability. It was also designed to assess the cost--both in supplies and personnel. (U)

An 8-channel AutoAnalyzer was employed with both standard and experimental antisera. The results were analyzed in accordance with the objectives. (U)

The results indicate that the system is highly reliable, being virtually error-free, provided an appropriate sample is obtained for analysis. It is believed that the employment of this system will provide the US Army with a highly reliable, practical method for implementing the requirements of AR 40-3. The system appears clearly to be more cost-effective than one utilizing manual methods alone. (U)

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Automated Blood Grouping AutoAnalyzer						